Superconducting Alloys at Temperatures Above Absolute Zero SOV/56-36-1-48/62

ASSOCIATION: Institut fizicheskikh problem Akademii nauk SSSR (Institute of Physical Problems of the Academy of Sciences, USSR)

SUBMITTED: July 16, 1958

Card 4/4

24(5) SOV/56-36-3-39/71

AUTHORS: Abrikosov, A. A., Gor'kov, L. P., Dzyaloshinskiy, I. Ye.

TITLE: On the Application of the Methods of the Quantum Field Theory to Problems of Quantum Statistics at Finite Temperatures (O primenenii metodov kvantovoy teorii polya k zadacham kvantovoy statistiki pri konechnykh temperaturakh)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 36, Nr 3, pp 900-908 (USSR)

ABSTRACT: The present paper intends to formulate a variation of the thermodynamic perturbation theory which permits the full application of quantum-field theoretical methods to quantum statistics at finite temperatures. This method is in principle based on an extension of the method developed by Matsubara (Ref 4). In the Green's functions transition to "imaginary times" is made by $t \rightarrow -i\tau\hbar$, and from operators of second quantization in Schroedinger (Shredinger) representation $\tilde{\psi}, \tilde{\psi}^+$ transition is made to operators in "interaction representation" $\psi(\vec{r},\tau)$, $\psi^+(\vec{r},\tau)$; these new Green's functions are expanded according to the imaginary time variable in Fourier series.

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On the Application of the Methods of the Quantum Field Theory to Problems of Quantum Statistics at Finite Temperatures SOV/56-36-3-39/71

This procedure differs from the usual one by the fact that integration with respect to frequencies is replaced by summation over discrete values of the imaginary "frequency" $i\omega_n$; otherwise this method is fully equivalent to the usual diagram-technique in the momentum space at $T = 0$. In the following, the analytical properties of the Fourier (Fur'ye) components of the Green's functions are investigated and it is shown that, due to the possibility of analytical continuation, it suffices for the treatment of various kinetic and non-steady problems to know the corresponding equilibrium Green's functions. The authors finally thank Academician L. D. Landau and L. P. Pitayevskiy for discussing the results obtained by this paper. There are 4 figures and 9 references, 5 of which are Soviet.

ASSOCIATION: Institut fizicheskikh problem Akademii nauk SSSR (Institute for Physical Problems of the Academy of Sciences, USSR)

SUBMITTED: December 4, 1958

Card 2/2

24 (5)

AUTHOR: Gor'kov, L. P.

SOV/56-36-6-41/66

TITLE: The Microscopic Deduction of the Ginzburg-Landau Equations in the Superconductivity Theory (Mikroskopicheskiy vyvod uravneniy Ginzburga-Landau v teorii sverkhprovodimosti)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 36, Nr 6, pp 1918 - 1923 (USSR)

ABSTRACT: The behavior of superconductors in a magnetic field near the critical temperature T_c (London temperature range) may easily be described by the phenomenological theory of Ginzburg and Landau (Ref 1). The author of the present paper shows that the Ginzburg-Landau equations can be deduced from the theory of superconductivity in the T_c-range. The investigations are based upon the equations deduced in an earlier paper (Ref 2) which contain the thermodynamic Green functions; from the latter the author passes on to Fourier components, and the expression $\Delta^*(\vec{r}) = gF^+(\tau, \vec{r}; \tau, \vec{r})$ goes over into $\Delta^*(\vec{r}) = T\sum_n \mathfrak{F}^+_\omega(r,r)$; $\Delta(\vec{r})$ is a function of the interaction constant and the func-

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The Microscopic Deduction of the Ginzburg-Landau Equations in the Superconductivity Theory SOV/56-36-6-41/66

tion $F^+(x,x')$ for coinciding arguments; without field $\Delta = 0$. Finally, an equation for the current $\vec{j}(\vec{r})$ is deduced, which, after introduction of the "wave function" $\Psi(\vec{r}) = \Delta(\vec{r})\sqrt{7\zeta(3)N}/4\pi T_c$, has the form:

$\vec{j}(\vec{r}) = -\frac{ie^*}{2m}\left(\Psi^*\frac{\partial\Psi}{\partial\vec{r}} - \Psi\frac{\partial\Psi^*}{\partial\vec{r}}\right) - \frac{e^{*2}}{mc}\vec{A}|\Psi|^2$. The introduction of the doubled electron charge $e^* = 2e$ corresponds to the physical significance of the "wave function" $\Psi(x)$ as the wave function of Cooper pairs. N denotes the electron density in normal metal; $\zeta(x)$ is Rieman's zeta function. The phenomenological constant $\varkappa$ is determined like in the old theory. For the critical magnetic field strength H_{cm} and the penetration depth δ_0 and $e^* = 2e$ it is determined as amounting to $\varkappa = \frac{\sqrt{2}e^*}{\hbar c} H_{cm}\,\delta_0^2$ and $\varkappa \approx 0.96\,\delta_L/\xi_0$ respectively; $\delta_L^{-1} = (4\pi Ne^2/mc^2)^{1/2}$ is the London penetration depth, $\xi_0 = 0.18\hbar v/kT_c$ is the non-locality parameter according to Bardeen, Cooper, and Schrieffer (Ref 5).

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The Microscopic Deduction of the Ginzburg-Landau Equations in the Superconductivity Theory SOV/56-36-6-41/66

For tin $\varkappa \approx 0.14$ and for aluminum 0.01 is obtained. For tin the formulas for $\sigma_{ns}(8\pi/H_c^2)$ as functions of T/T_c are finally given, both according to Ginzburg, Yu. V. Sharvin (Ref 9) and according to Faber (Ref 10). The author finally thanks Academician L. D. Landau for valuable advice, and V. L. Ginzburg for discussions. There are 10 references, 7 of which are Soviet.

ASSOCIATION: Institut fizicheskikh problem Akademii nauk SSSR (Institute for Physical Problems of the Academy of Sciences, USSR)

SUBMITTED: February 3, 1959

Card 3/3

24 (3)

AUTHORS: Abrikosov, A. A., Gor'kov, L. P., Khalatnikov, I. M. SOV/56-37-1-29/64

TITLE: The Analysis of Experimental Data on the Surface Impedance of Superconductors (Analiz eksperimental'nykh dannykh o poverkhnostnom impedanse sverkhprovodnikov)

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 37, Nr 1(7), pp 187 - 191 (USSR)

ABSTRACT: The authors compare the experimental data on the measurement of the surface impedance of superconductors for different frequencies with the conclusions drawn from the new theory of superconductivity. The properties of superconductors in a high-frequency field were investigated in a previous paper of the authors (Ref 1) and in a paper by D. C. Mattis and J. Bardeen (Ref 2). The present paper compares the theory with the experimental data on the surface impedance of superconductors. The authors give, above all, formulas for the surface impedance in various limiting cases which are suitable for a convenient comparison with the experiment. The amount usually measured by experiment, of the ratio between the impedance $Z(\omega)$ in supercon-

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The Analysis of Experimental Data on the Surface Impedance of Superconductors SOV/56-37-1-29/64

ductive state and the real part of the impedance in the normal state is given by the formula $Z(\omega)/R_n = -2i(\pi\omega/\Delta Q(\omega))^{1/2}$ in Pippard's limiting case. An expression for the complex function $Q(\omega)$ is then written down, and an expression for the frequency dependence of the impedance follows subsequently. Now the authors analyze the temperature dependence for various frequencies at temperatures different from zero. The following cases are investigated in detail (the quantity 2Δ denoting the gap, in the energy spectrum at a given temperature): (a) $\omega \ll \Delta(0)$, (b) $\omega \sim \Delta(0)$: This very case is the most difficult one for comparing theory with experiment, for the quantities Δ, ω and T are, over a large part of the temperature interval $0 < T < T_c$, of the same order of magnitude. The expression for $Q(\omega)$ can only be simplified in the range of low temperatures $T \ll \omega \sim \Delta$. (c) $\omega \gg \Delta(0)$. In this case, only the ratio between T and Δ changes, and ω is always large with respect to these two quantities. The formulas written down in the present paper permit a detailed comparison of theory with numerous experimental data.

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The Analysis of Experimental Data on the Surface Impedance of Superconductors SOV/56-37-1-29/64

In the range of very high frequencies $\omega \gg$, no experimental data have become known up to date. The causes of disagreement between the experimental data and the values of impedance calculated by the new theory of superconductivity have not yet been clarified. There are 3 figures and 6 references, 3 of which are Soviet.

ASSOCIATION: Institut fizicheskikh problem Akademii nauk SSSR (Institute of Physical Problems of the Academy of Sciences, USSR)

SUBMITTED: February 3, 1959

Card 3/3

24 (8)

AUTHOR: Gor'kov, L. P. SOV/56-37-3-36/62

TITLE: The Critical Supercooling Field in the Theory of Superconductivity

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1959, Vol 37, Nr 3 (9), pp 833-842 (USSR)

ABSTRACT: The phase transition from the normal to the superconductive state occurring at a certain value of the magnetic field strength is a transition of the first kind for a massive sample. The value of the critical field H_c may be obtained on the basis of the thermodynamical theory and was calculated by Bardeen, Cooper, and Schrieffer (Ref 1). Besides the thermodynamical main field, two further critical field values, however, exist at a given temperature, viz. the so-called "superheating" field and the "supercooling" field H_{c1}. These fields determine the range of the possible hysteresis: If the field is stronger than H_c but weaker than the superheating field, the metal is in a metastable superconductive phase, and if the field is weaker than H_c but stronger than H_{c1}, it is in a metastable normal phase. For the determination of these critical field values thermodynamical considerations are not sufficient, and it is necessary to return to the microscopical theory of supercon-

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ductivity. By using a method developed in an earlier paper (Ref 2), the author in the present paper gives derivations of formulas for the determination of the amount of H_{c1}. Derivations are carried out step by step and are discussed in detail. The following is obtained as approximation formula (variation method): $H_{c1} \approx (e^2\gamma/2)(c\Delta_o^2/ev)$, and for T = 0, $H_c = \Delta_o\sqrt{2mp_o/\pi}$. Then, $H_{c1}/H_c = 1.77(3\pi T_c mc/e)(2\pi m/7\zeta(3)p_o^5)^{1/2}$ ($\zeta(x)$ is Riemann's zeta function, $\zeta(3) = 1.202$). If the product of the parentheses in the right side of the above equation is denoted by $\varkappa$, then $H_{c1}/H_c = 1.77\,\varkappa$. According to Ginzburg and Landau (Ref 5) $H_{c1}/H_c = \sqrt{2}\varkappa$ near T_c holds; thus, the ratio varies within this entire temperature interval only by 25%. The following considerations apply to the determination of $\varkappa$: $\varkappa$ may be expressed as a function of the density of the free electrons $n = p_o^3/3\pi^2$ (p_o - Fermi momentum): $\varkappa = 0.485\, kT_c cm^{3/2}/e\hbar^2 n^{5/6}$. The electron mass m and the

quantity κ may be determined experimentally. For aluminum the author finds the value κ ≈ 0.0[illegible]2 (In reference 9 0.011 was found). For tin the values 0.155 (Ref 9) and 0.158 (Ref 10) are given, for lead 0.234 and for indium 0.22 (Ref 11). Further considerations deal with the temperature dependence of the ratio of the critical field strengths. The following is obtained: $H_{c1}/H_{c} = \kappa\left[1.77 - 0.45(T/T_c)^2 + 0.07(T/T_c)^4\right]$. The author thanks Academician L. D. Landau for his interest and valuable advice, and Professor V. L. Ginzburg for remarks. There are 14 references, 10 of which are Soviet.

ASSOCIATION: Institut fizicheskikh problem Akademii nauk SSSR (Institute of Physical Problems of the Academy of Sciences, USSR)

SUBMITTED: April 23, 1959

L.P. Gorkov

24(0)

SOV/53-67-4-7/7

AUTHOR: Chentsov, R.

TITLE: The Fifth All-Union Conference on the Physics of Low Temperatures (5-ye Vsesoyuznoye soveshchaniye po fizike nizkikh temperatur)

PERIODICAL: Uspekhi fizicheskikh nauk, 1959, Vol 67, Nr 4, pp 743-750 (USSR)

ABSTRACT: This Conference took place from October 27 to November 1 at Tbilisi; it was organized by the Otdeleniye fiziko-matematicheskikh nauk Akademii nauk SSSR (Department of Physico-mathematical Sciences of the Academy of Sciences, USSR), the Akademiya nauk Gruzinskoy SSR (Academy of Sciences, Gruzinskaya SSR), and the Tbilisskiy gosudarstvennyy universitet im. Stalina (Tbilisi State University imeni Stalin). The Conference was attended by about 300 specialists from Tbilisi, Moscow, Khar'kov, Kiyev, Leningrad, Sverdlovsk, and other cities as well as by a number of young Chinese scientists at present working in the USSR. About 50 lectures were delivered which were divided according to research fields.

II. Supraconductivity. 13 lectures were delivered on this field of which two were experimental and the others theoretical. Reports on experimental investigations of supraconductivity were delivered by Yu. V. Sharvin and V. P. Gantmakher (IFP) and N. V. Zavaritskiy (IFP). The former investigated the structure of the intermediate state in monocrystals of pure tin, the latter measured the thermal conductivity of differently shaped orientated cylindrical gallium samples at 0.1 - 4.2°K. A. A. Abrikosov, L. P. Gor'kov and I. M. Khalatnikov (IFP) theoretically investigated the behavior of a superconductor in the high-frequency field. V. L. Ginzburg and G. F. Zharkov (FIAN) dealt with the microscopical theory, and Ginzburg discussed among other things the part played by fluctuations in phase transitions of the second kind. I. M. Lifshits (KhFTI) showed that it follows from the modern theory of supraconductivity in consideration of the anisotropy of metals that, in principle, the existence of supraconductors is possible which are supra-conductive only within a limited range of temperature (and not at all temperatures below the critical ones). B. T. Geylikman and V. Z. Kresin (IAE) investigated the electron- and phonon thermal conductivity of supraconductors by means of the microscopical theory at temperatures that are not very near absolute zero. V. V. Buykov and L. E. Gurevich (FTI AN SSSR) spoke about the surface energy on the boundary between the supraconductive and normal phases. D. N. Zubarev and Yu. A Tserkovnikov (Matematicheskiy institut AN SSSR - Mathematics Institute AS USSR) dealt with the thermodynamics of the supraconductive state (Froehlich-model), V. V. Tolmachev (MIAN) investigated the problem of collective excitations in a supraconductor. D. V. Shirkov (Ob"yedinennyy institut yadernykh issledovaniy - Joint Institute of Nuclear Research) spoke about consideration of Coulomb-interaction of electrons in semiconductors. The problem of consideration of the Coulomb interaction was discussed by Chen' Ch'un-hsien and Chou, Hsi-hsin (PRC).

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GOR'KOV, L. P., Doc Phys-Math Sci -- (diss) "Methods of the quantum field theory in the theory of superconductivity." Moscow, 1960. 19 pp; (Academy of Sciences of the USSR, Inst of Physical Problems); 150 copies; price not given; list of authors' works at end of text (15 entries); (KL, 18-60, 146)

Gor'kov, L.

2) A Ya Boyarskiy - The Differential Equations of Expanded Reproduction

3) L V Kantorovich - Optimal Planning and Economic Indicators

4) A A Konyus - Mathematical Analysis of the Organic Composition of Production

5) N I Vedute - Mathematical Analysis of Rates and Proportions in the National Economy (Primarily in Determining the Economic Efficiency of Capital Investment)

6) B I Plyushin, N P Nazarov - Price Relationships in Expanded Reproduction

7) L M Dudkin and V S Vaksman - Statistical [sic] and Dynamic Models of a Socialist National Economic Balance in Physical Terms

c. Evening Session - 15 December 1959, 1600 hours
II. The Theory of Linear Programming

1) G S Rubinshtein - Review of Methods for the Solution of Linear Programming Problems

2) A L Lur'ye - Algorithmic Solutions of Transport Problems Through Approximation by Means of Hypothetically Optimal Plans

3) Ya P Gerchuk - The Algebra of Linear Programming

4) B V Kishal'shteyn - Recommendation for a Method of Re-computing Matrices of Total Input Coefficients under Conditions of Changing Technology.

5) E Chetyrkin - A Practical Interpretation of Kantorovich's Controlling Multipliers

6) Titov and Barsov - Linear Programming Methods and Material Supply

d. Morning Session - 16 December 1959, 1000 hours
III. Economic Models and Dynamic Programming

1) V V Novozhilov - Mathematical Models of the National Economy in Bourgeois Economics and a Critique Thereof

2) B M Mikhalevskiy - Mathematical Methods of Determining the Maximum Efficiency of Capital Investment

3) V V Chlyugmanich - Concerning the Economic Cycle Models and Dynamic Economic Models of Bourgeois Econometricians

4) V V Trigubenko - Problems in the Application of Dynamic Programming in Economic Research Abroad

5) L Gor'kov - Single-Product Economic Models and the Analysis of Certain Economic Indicators

6) V I Romanovskiy - The Dynamic Programming Method and Its Use in Economics

7) D I Cparin - The Unfolding (stvornaya) Matrix as a Model for the Application of Mathematical Methods in Long-Term Economic Planning

e. Evening Session - 16 December 1959, 1600 hours
IV. The Transportation Problem

1) D I Volovoy - Finding the Most Suitable Assignment of Various Types of Fleet Vessels to Lines

2) A M Faynzil'berg - Extremital Methods in Economic Research on the Optimum Spatial Distribution of Projects

3) Z P Rumyantseva - The Application of Linear Programming to Air Transport Economics

report submitted at the Soviet Conference on Problems in the Application of Mathematical Methods in Economic Research, Leningrad, 1[illegible]-21 January 1960.

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9.9845 (1538)

S/570/60/000/017/007/012
E032/E114

AUTHORS: Gor'kov, L.P., Dzyaloshinskiy, I.Ye., and Pitayevskiy, L.P.

TITLE: Calculations of fluctuations in quantities described by transport equations

SOURCE: Akademiya nauk SSSR. Institut zemnogo magnetizma, ionosfery i rasprostraneniya radiovoln. Trudy, no.17(27). Moscow, 1960. Rasprostraneniye radiovoln i ionosfera. 203-207

TEXT: The authors discuss fluctuations in quantities which can be described by transport equations, e.g. the equations of Boltzmann, Fokker-Planck and Landau, in the case of a Coulomb interaction between the particles. The knowledge of these fluctuations is essential to the theory of scattering of electromagnetic waves in rarefied gases and electron plasma. The method employed is analogous to that used by L.D. Landau and Ye.M. Lifshits (Ref.2: Electrodynamics of uniform media, M., Gostekhizdat, 1957, Ref.3: ZhETF, v.32, 618, 1957). It consists in the introduction into the transport equation of additional random

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terms whose correlations are then determined on the basis of the general theory of fluctuations. For example, the Boltzmann equation is modified to read

$$\frac{\partial \nu}{\partial t} + (\underline{v}\nabla)\nu = J + y \tag{1}$$

where the collision integral J is given by

$$J = \iint w(p_1, p_1'; p, p') \{n_o(p_1)\nu(p_1') + n_o(p_1')\nu(p_1) - n_o(p')\nu(p) - n_o(p)\nu(p')\} d^3p_1 d^3p_1' d^3p' \tag{2}$$

and y is the "random" collision integral. The problem consists in the evaluation of the average of $y(p,r,t)y(p',r',t')$. It is shown that this average is in fact given by:

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$$\overline{y(p,r,t)y(p',r',t')} = 2\delta(r - r')\delta(t - t') \times$$

$$\times \Big\{ - n_o(p') \iint w(p',p_1;\ p_1,p_1')\ n_o\ (p_1)\ d^3p_1 d^3p_1' -$$

$$- n_o(p) \iint w(p',p_1;\ p_1,p_1')\ n_o\ (p_2')\ d^3p_1 d^3p_1' +$$

$$+ \delta(p - p')n_o(p) \iiint w(p_1',p_1'';\ p,\ p_1)n_o(p_1)\ d^3p_1' d^3p_1'' d^3p_1 +$$

$$+ n_o(p)n_o(p') \iint w(p_1,p_1';\ p,\ p')\ d^3p_1 d^3p_1' \Big\} \qquad (9)$$

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which is equivalent to the results obtained by B.B. Kadomtsev (Ref.5: ZhETF, v.32, 943, 1957). It can be shown that the introduction of the "random" collision integral into Eq.(1) does not upset the conservation of the number of particles, energy and momentum. Another transport equation considered is the following:

$$\frac{\partial \nu}{\partial t} + (\underline{v}\,\nabla)\nu = - \operatorname{div} j \qquad (10)$$

where j is the current density in the momentum space. Here it is convenient to introduce a "random" current y so that

$$\frac{\partial \nu}{\partial t} + (\underline{v}\nabla)\nu = - \operatorname{div}(j + y)$$

Expressions analogous to Eq.(9) are then derived. An account of the general theory of fluctuations on which these calculations are based is given in "Statistical Physics" by L.D. Landau and Ye.M. Lifshits (Ref.4: izd. 3 M., Gostekhizdat, 1951). The method can be used for fluctuations in the equations for fermi and bose gases. A.A. Abrikosov and I.M. Khalatnikov (Ref.7: ZhETF, v.34, 198, 1958) have used it to study light scattering in liquid He^3. Acknowledgments are expressed to L.D. Landau and Ye.M. Lifshits for discussions. S.M. Rytov and B.B. Kadomtsev are mentioned in connection with their contributions to the theory of fluctuations. There are 7 Soviet-bloc references.

4

S/030/60/000/009/012/016
B021/B056

AUTHOR: Gor'kov, L. P., Candidate of Physical and Mathematical Sciences

TITLE: Problems of the Physics of Low Temperatures

PERIODICAL: Vestnik Akademii nauk SSSR, 1960, No. 9, pp. 110 - 112

TEXT: From June 23 to 28, 1960, the 7th All-Union Conference on Low Temperature Physics took place at Khar'kov. The opening address was delivered by P. L. Kapitsa, who said that the physics of low temperatures had developed into a large field of science. Since 1938, when P.L.Kapitsa discovered the phenomenon of He II super-fluidity and 1941 when L. D. Landau explained this phenomenon, He II has been the object of numerous experimental and theoretical investigations. Furthermore, the following lectures are mentioned: E. L. Andronikashvili, R. A. Bablidze, Yu. G. Mamaladze, S. G. Matinyan, K. B. Mesoyed, and D. S. Tsakadze spoke about the further research of vortex properties; V. P. Peshkov - results obtained by experiments with critical velocities in capillary tubes; I. M. Khalatnikov - analysis of the phenomenon of the "Kapitsa-temperature

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origin"; N. N. Bogolyubov - the problem of superconductivity; P. A. Bezuglyy and A. A. Galkin - the discovery of the anisotropy of the absorption coefficient of longitudinal sound in tin. N. V. Zavaritskiy - results obtained by measuring thermal conductivity; A. A. Abrikosov and L. P. Gor'kov - the influence exerted by the so-called "paramagnetic" impurities on superconductivity; B. G. Lazarev, Ye. Ye. Semenenko, A. I. Sudovtsov, Ye. I. Nikulin, N. M. Reynov, and A. P. Smirnov - the possibility of the existence of superconductive metal modifications in form of foils; I. M. Lifshits - problems of the physics of metals; N. Ye. Alekseyevskiy, Yu. P. Gaydukov, I. M. Lifshits, and V. G. Peschanskiy - the anisotropy of the energy spectrum of tin; M. S. Khaykin - the so-called cyclotron resonance in tin, which had been theoretically predicted by M. Ya. Azbel' already several years ago; E. A. Kaner, A. A. Galkin, A. P. Korolyuk, N. B. Brandt, and Yu. A. Bychkov - the further development in this field. A report was given on problems of magnetism by D. I. Astrov, I. Ye. Dzyaloshinskiy, and R. T. Minaya. 100 reports were submitted to the conference.

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S/056/60/039/002/036/044
B006/B070

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AUTHORS: Abrikosov, A. A., Gor'kov, L. P.

TITLE: The Problem of Knight Shift in Superconductors

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 2(8), pp. 480 - 483

TEXT: A number of scientists have interested themselves in the theory of Knight shift in semiconductors (displacement of the nuclear resonance frequency as compared with that of dielectrics). The purpose of the present paper was to explain the experimental data. The Knight shift is due to the paramagnetism of the conduction electrons. Since the electron wave function is anomalously large in the neighbourhood of the nucleus, the magnetization of the electrons causes a change in the magnetic field acting upon the nucleus; the deviation of the effective field from the external one is given by $\Delta H = (8\pi/3N_{at})|\psi(0)|^2\chi H$, where $|\psi(0)|^2$ is the probability density of the electron at the position of the nucleus. N_{at}

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The Problem of Knight Shift in Superconductors S/056/60/039/002/036/044
B006/B070

is the number of atoms per unit volume, χ is the electronic susceptibility, and H is the external field. The authors first discuss the results and methods of other related works, and show that a homogeneous field can exist only in such semiconductors whose dimensions are very small compared to the depth of penetration, δ, of the static field. (The experimental work was done with an emulsion of a semiconductor). A consideration of massive semiconductor in a homogeneous field (e.g. Ref. 1) corresponds to no practical situations. Also, the results obtained by other authors (Refs. 3,4) relating to the effect of impurities are criticized and the errors indicated. The authors of the present work have elaborated in earlier publications a method for the theoretical investigation of semiconductors with impurities. Here an expression for the spin magnetic moment of the electron system in a homogeneous magnetic field is first written down and transformed. The impurities are taken into account in a manner completely analogous to Refs. 7 and 8. The experiments show, in particular, that for T = 0 the susceptibility χ vanishes and therefore there can be no Knight shift. (The authors of Refs. 3,4 found the opposite result; also experimentally χ was not found to be zero for T = 0). In this connection, the authors also comment on

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The Problem of Knight Shift in Superconductors S/056/60/039/002/036/044
B006/B070

the interpretation of the experiment of Reif (Ref. 5). For low temperatures, the field was no more homogeneous, as is also indicated by the large width of the resonance line. A discussion is also given of the characteristics of transition from the supraconducting to normal state for particles which are smaller than the depth of penetration of the field. The authors finally thank Academician L. D. Landau for discussions. There are 9 references: 3 Soviet and 6 US.

ASSOCIATION: Institut fizicheskikh problem Akademii nauk SSSR (Institute of Physical Problems of the Academy of Sciences of the USSR)

SUBMITTED: March 23, 1960

Card 3/3

88460
S/056/60/039/006/052/063
B006/B063

24.2140 (1072,1158,1160)

AUTHORS: Abrikosov, A. A., Gor'kov, L. P.

TITLE: Theory of Superconductive Alloys With Paramagnetic Impurities

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, 1960, Vol. 39, No. 6(12), pp. 1781-1796

TEXT: Experiments on the effect of paramagnetic impurities upon the critical temperature of superconductors have shown that an admixture of such elements leads to a decrease of T_c, whereas an admixture of ferromagnetic elements (e.g., to titanium - Ref. 4) results in an increase of T_c. A study of this phenomenon has been made on the basis of a microscopic theory of superconductivity. The mechanism of superconductivity is related to the formation of bound electron pairs in the singlet state. Exchange interaction between electrons and spinning impurity atoms leads to nonconservation of the electron spin, which indicates the formation of Cooper pairs. Thus, the spin of the impurity atoms is likely to complicate

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Theory of Superconductive Alloys With Paramagnetic Impurities

S/056/60/039/006/052/063
B006/B063

the occurrence of superconductivity and causes a decrease in T_c. This assumption was confirmed by a theoretical study described here. It is assumed that the interaction of an electron with an impurity atom is described by an expression in which the exchange term $\hat{v}(\vec{r}) = u_1(\vec{r}) + u_2(\vec{r})(\vec{S}\vec{\sigma})$ is contained; $\vec{S}$ is the momentum of the impurity atom, and $\hat{\sigma}$ is the electron spin matrix. The Hamiltonian describing the interaction between electrons and impurity atoms is assumed to be given by $H_{int} = (\psi^+\hat{V}\psi) = (\psi^+ \sum_a \hat{v}(\vec{r} - \vec{r}_a)\psi)$ (second-quantization representation). First, the dependence of the transition temperature T_c on the impurity concentration is described. Following a previous paper, the superconductor is described by two Green functions. When the impurity concentration is small ($\varrho \ll 1$), the critical temperature drops in proportion to the impurity concentration: $T_c = T_{co} - \pi/4\tau_s$. If $\varrho \gg 1$, i.e., $T_c/T_{co} \ll 1$, then $T_c^2 = (6/\pi^2\tau_s^2)\ln(\pi T_{co}\tau_s/2\gamma)$. At a certain critical concentration of the

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88460'

Theory of Superconductive Alloys With Paramagnetic Impurities

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paramagnetic impurities, which is determined by the condition $\tau_{s\ cr} = 2\gamma/\pi T_{co}$ there is no superconductivity any longer throughout the temperature range. The critical path is given by $l_{s\ cr} = v\tau_{s\ cr} \sim 10^{-4}$ cm. In addition, the thermodynamic and electromagnetic properties of alloys within the range of critical concentration have been studied, i.e. at $\tau_s \approx \tau_{s\ cr}$. It is noted that the expression for the ratio between the specific heats of the superconductive and the normal phase contains no exponential term at $T \to 0$. This means that there is not gap in the spectrum of these superconductors and, consequently, no absorption threshold for electron magnetic radiation at $T = 0$. Finally, the dependence of the spectrum gap at $T = 0$ on the impurity concentration is described. The gap disappears at a concentration that is somewhat lower than the critical one ($n' = 2e^{-\pi/4} n_{cr} \approx 0.91\ n_{cr}$), and the spectrum remains continuous at higher concentrations. L. D. Landau is thanked for discussions. N.N. Bogolyubov, V. L. Ginzburg, A. B. Migdal, V. M. Galitskiy, and A. I. Shal'nikov are mentioned. There are 4 figures and 17 references: 9 Soviet and 8 US.

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88460

Theory of Superconductive Alloys With Paramagnetic Impurities

S/056/60/039/006/052/063
B006/B063

ASSOCIATION: Institut fizicheskikh problem Akademii nauk SSSR (Institute of Physical Problems, Academy of Sciences USSR)

SUBMITTED: July 25, 1960.

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S/030/61/000/009/009/013
B105/B101

AUTHOR: Gor'kov, L. P., Doctor of Physics and Mathematics

TITLE: Problems of the theory of solids and of quantum statistics

PERIODICAL: Akademiya nauk SSSR. Vestnik, 31 no. 9, 1961, 121-122

TEXT: A well-attended joint symposium on the theory of solids and new statistical methods was held by the Odesskiy universitet (Odessa University) and the Institut fizicheskikh problem im. S. I. Vavilova Akademii nauk SSSR (Institute of Physical Problems imeni S. I. Vavilov of the Academy of Sciences USSR) in Odessa from May 21 to 30, 1961. The present state of the semiconductor theory, general problems of quantum statistics, and the theory of metals and semiconductors were discussed. A. A. Abrikosov and L. P. Gor'kov (Moscow) reviewed past achievements, and G. M. Eliashberg (Leningrad) discussed general statistical problems. In addition, the latter lectured on the derivation of the kinetic equation for excitation in the Fermi liquid (theory of the liquid isotope He^3 at low temperatures). D. N. Zubarev (Moscow) spoke of generalizing the notion of statistical operator in quantum statistics to cover the case of

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nonequilibrium processes. The following reports are mentioned: I. M. Lifshits (Khar'kov) on arguments backing the statement that the so-called Fermi liquid effects are not important in studies of the energy spectrum of electrons in metals; L. D. Landau on the essential role played in a number of cases by excitation interactions in the theory of Fermi liquids; V. G. Skobov (Leningrad) on ultrasonic attenuation in the magnetic field of metals in the presence of impurities; V. G. Vaks, A. I. Larkin, and V. M. Galitskiy (Moscow) on so-called collective excitations in superconductors. V. L. Pokrovskiy (Novosibirsk) on the theory of superconductivity in an anisotropic metal; L. V. Keldysh (Moscow) reviewed the principal problems and latest findings in the theory of semiconductors; E. I. Rashba (Kiyev) on his findings concerning wurtzite-type semiconductors; G. E. Pikus (Leningrad) on the effect of deformations on the electronic spectrum in semiconductors; A. I. Larkin and V. G. Vaks on the theory of superconductivity as utilized to set up a model of elementary particles; A. A. Vedenov (Moscow) and R. Sagdeyev (Novosibirsk) on the mechanism of energy transfer in plasma from a particle beam to plasma oscillations. The latter researchers succeeded in setting up a kinetic equation covering this process.

GOR'KOV, L.P.; GALITSKIY, V.M.

Superfluidity in a Fermi system in the presence of pairs with nonzero angular momentum. Zhur. eksp. i teor. fiz. 40 no.4:1124-1127 Ap '61. (MIRA 14:7)

1. Institut fizicheskikh problem AN SSSR.
(Superfluidity) (Fermi surfaces)

GOR'KOV, L.P.; MELIK-BARKHUDAROV, T.K.

Theory of the superfluidity of an imperfect Fermi gas. Zhur. eksp. i teor. fiz. 40 no.5:1452-1458 My '61. (MIRA 14:7)

1. Institut fizicheskikh problem AN SSSR.
(Quantum field theory)
(Electron gas)

26710

24.2200 (1049, 1121, 1137)

S/056/61/041/005/025/038
B102/B138

AUTHORS: Bychkov, Yu. A., Gor'kov, L. P.

TITLE: Quantum oscillations of the thermodynamic quantities of a metal in a magnetic field according to the Fermi fluid model

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 41, no. 5(11), 1961, 1592-1605

TEXT: L. D. Landau's theory of the Fermi fluid (ZhETF, 30, 1058, 1956; ibid. 35, 97, 1958) is applied to investigate the de Haas-van Alphen effect for the electrons in a metal. The Fermi fluid is assumed to be isotropic and the long-range part of the Coulomb interaction to be screened. To determine the energy spectrum of the electrons, the authors start from an investigation of the properties of the Green functions of electrons in a magnetic field:

$$G(\mathbf{r}, \mathbf{r}'; t-t')\,\delta_{\alpha\beta} = -i\langle T(\psi_\alpha(\mathbf{r}, t)\,\psi_\beta^+(\mathbf{r}', t'))\rangle. \qquad (1)$$

The field operators $\psi_\alpha(x)$ and $\psi_\beta^+(x')$ include field dependence. In the

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Quantum oscillations of the... S/056/61/041/005/025/038
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following, the Fourier components $G(\vec{r}, \vec{r}'; \varepsilon)$ of (1) through the time difference (t-t') are considered in the Dyson equation

$$\left[\varepsilon + \mu - \frac{1}{2m}\left(\hat{p} - \frac{e}{c} A\right)^2\right] G(r, r'; \varepsilon) - \int \Sigma(r, r''; \varepsilon)\, G(r'', r'; \varepsilon)\, d^3r'' = \delta(r - r'). \qquad (6)$$

$\hat{\vec{p}} = -i\partial/\partial r$, μ - chemical potential of the electrons in the magnetic field, $\sum(\vec{r}, \vec{r}''; \varepsilon)$ is the so-called self-energy part, caused by particle interaction in the Fermi fluid. The vector potential is defined by $\vec{A}(\vec{r}) = \{-Hy, 0, 0\}$. For small ε and H=0 the function $G^0(\vec{p}, \varepsilon)$ has a pole near the Fermi surface: $G^0(\vec{p}\,\varepsilon) = a/(\varepsilon - v(p-p_0) + i\delta(\varepsilon))$. The spectrum of the Fermi fluid is defined by $\varepsilon = v(p-p_0)$, i.e. from the eigenvalues of the operator which stands within the brackets of (6). The electron interaction Hamiltonian in secondary-quantization representation is given by

$$\hat{H}_{int} = \int \psi^+(r') \left[-\frac{e}{2mc}(\hat{p} - \hat{p}')_x + \frac{e^2 Hy}{2mc^2}\right] Hy\psi(r)\, d^3r, \qquad (7)$$

$\hat{p}_x = -i\partial/\partial x$. The authors show that the electron energy spectrum in the magnetic field can be determined from (5) with regular quasiclassical

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Quantum oscillations of the... S/056/61/041/005/025/038 B102/B138

quantization, as proposed by I. M. Lifshits and A. M. Kosevich (ZhETF, 29, 780, 1955). Where the electrons are near the Fermi surface as in the de Haas-van Alphen effect

$$G(\mathbf{p}, \mathbf{p}'; \varepsilon) = \sum_n \psi_n(\mathbf{p}) \psi_n^*(\mathbf{p}') \delta(p_x - p_x') \delta(p_z - p_z') G_n(p_z, \varepsilon),$$

$$G_n(p_z, \varepsilon) = a/(\varepsilon + p_0^2/2m^* - (n + 1/2)\omega^* - p_z^2/2m^* + i\delta(\varepsilon)), \qquad (15)$$

is found, with $\omega^* = eH/m^*c$; the constants a, m^* and p_0 contain terms which are functions of $H^{3/2}$. The singularity near the Fermi surface is determined by $G^0(\vec{p}, \varepsilon) = \dfrac{a}{\varepsilon - v(p - p_0) + i\delta(\varepsilon)} + g(\vec{p}, \varepsilon)$. The Green function in coordinate representation is given by

$$G(\mathbf{r}, \mathbf{r}'; \varepsilon) = \exp[-i(eH/2c)(x - x')(y + y')] \times$$

$$\times \frac{eH}{c(2\pi)^3} \sum_n e^{-eH\rho^2/4c} L_n\left(\frac{eH}{2c}\rho^2\right) \int \frac{a e^{ip_z(z-z')} dp_z}{\varepsilon + p_0^2/2m^* - (n + 1/2)\omega^* - p_z^2/2m^* + i\delta(\varepsilon)} =$$

$$= \exp\{-i(eH/2c)(x - x')(y + y')\} \overline{G}(\mathbf{R}, \varepsilon), \qquad (17)$$

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where $L_n(x)$ is a Laguerre polynomial. The formulas derived are then applied to study the influence of the Fermi-fluid effects upon the oscillation of the thermodynamic quantities of a metal in a magnetic field. The variation of the particle density N with the chemical potential μ is first investigated for $N = -iG_{\alpha\alpha}(x,x')_{x' \to x, t' \to t+0}$. In Fourier representation

$$\frac{\partial N}{\partial \mu} = \frac{i}{2\pi}\int d\omega \int G_{\alpha\gamma}(\mathbf{r}, \mathbf{l}; \omega)\, G_{\gamma\alpha}(\mathbf{l}, \mathbf{r}; \omega)\, d^3\mathbf{l} -$$
$$- \frac{1}{(2\pi)^2}\iint d\omega d\omega' \int d^3s_1 d^3s_2 d^3s_3 d^3s_4 d^3\mathbf{l}\, G_{\alpha\alpha_1}(\mathbf{r}, s_1; \omega)\, G_{\alpha_4\alpha}(s_4, \mathbf{r}; \omega) \times$$
$$\times \Gamma_{\alpha_1\alpha_2,\alpha_3\alpha_4}(s_1, \omega; s_2, \omega'; s_3, \omega'; s_4, \omega)\, G_{\beta\alpha_2}(\mathbf{l}, s_2; \omega')\, G_{\alpha_3\beta}(s_3, \mathbf{l}; \omega').$$

which can be transformed into

$$\frac{\partial N}{\partial \mu} = \frac{\sqrt{2m^* m^*}}{2\pi^2}\sqrt{\omega^*}\,\zeta\left(\frac{1}{2}, \frac{\Delta}{\omega^*}\right)\Phi^2,$$
$$\Phi = a\left\{1 + \frac{i}{2(2\pi)^4}\int \Gamma^{0k}_{\alpha\gamma,\gamma\alpha}(p_1, p_2)\, G^0(p_1, \omega)\, G^0(p_2, \omega)\, d^4p\right\} \qquad (29)$$

For $H = 0$

$$\Phi = a\left(\frac{\partial G^{-1}}{\partial \mu}\right)_{p=p_0,\, \omega=0} = \frac{p_0}{m^*}\frac{dp_0}{d\mu}. \qquad (29')$$

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and

$$\frac{\partial N}{\partial \mu} = \frac{1}{\sqrt{2m^*}\, 4\pi^2} \sqrt{\omega^*} \left(\frac{dp_0^2}{d\mu}\right)^2 \zeta\left(\frac{1}{2}, \frac{\Delta}{\omega^*}\right). \tag{30}$$

hold. For the oscillating part of the thermodynamic potential Ω

$$\delta\Omega_{\text{осц}} = -\frac{4m^{*2}\omega^{*5/2}}{3\sqrt{2m^*}\,\pi^2} \zeta\left(-\frac{3}{2}, \frac{\Delta}{\omega^*}\right) = \frac{m^{*3/2}\omega^{*5/2}}{4\pi^4} \sum_1^\infty r^{-5/2} \cos\left(2\pi r \frac{\Delta}{\omega^*} - \frac{\pi}{4}\right),$$

is found, which agrees in full with the formula found by Lifshits and Kosevich. Finally the influence of electron spin on the oscillations, i.e. of the interaction between the magnetic field and magnetic moment of the spin, is studied. It is found that

$$\frac{\partial N}{\partial \mu} = \frac{\sqrt{\omega^*}}{8\pi^2 \sqrt{2m^*}} \left(\frac{dp_0^2}{d\mu}\right)^2 \left\{\zeta\left(\frac{1}{2}, \frac{\Delta}{\omega^*} + \frac{\xi H}{2\omega^*}\right) + \zeta\left(\frac{1}{2}, \frac{\Delta}{\omega^*} - \frac{\xi H}{2\omega^*}\right)\right\},$$

and for the oscillating part of the thermodynamic potential

$$\sigma\Omega_{\text{осц}} = -\frac{2m^{*2}\omega^{*5/2}}{3\pi^2\sqrt{2m^*}} \left\{\zeta\left(-\frac{3}{2}, \frac{\Delta + \xi H/2}{\omega^*}\right) + \zeta\left(-\frac{3}{2}, \frac{\Delta - \xi H/2}{\omega^*}\right)\right\}. \tag{34}$$

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for the oscillating part of the magnetic moment

$$M_{\text{осц}} = -\frac{m^{*3/2}(\beta^* H)^{1/2}\mu}{2\pi^3 \hbar^3 H}\sum_{1}^{\infty}\frac{(-1)^r}{r^{3/2}}\cos\left(\frac{\xi}{\beta^*}\pi r\right)\sin\left(\pi r\frac{cp_0^2}{e\hbar H}-\frac{\pi}{4}\right),$$

where $\beta^* = e\hbar/m^*c$, $c = \gamma T$ and $\xi/\beta^* = 4\pi^2\chi/3\beta\beta^*\gamma$. The results show that the Lifshits-Kosevich procedure can be followed in order to determine oscillation periods. Deviation from the usual formulas occurs for the oscillation amplitudes and is due to the variation in the effective magneton excitation caused by electron interaction. Without taking account of spin susceptibility an expression for M_{osc} may be found from the usual representation of the electron system as a quasi-particle gas. This conclusion agrees with that of Luttinger. L. P. Pitayevskiy (ZhETF, 37, 1794, 1959) and A. A. Abrikosov and I. M. Khalatnikov (UFN, 66, 177, 1958) are mentioned, Academician L. D. Landau is thanked for discussions. There are 4 figures and 11 references: 8 Soviet and 3 non-Soviet. The latter read as follows: J. M. Luttinger. Phys. Rev. 121, 1251, 1961; E. Sondheimer, A. Wilson. Proc. Roy. Soc., A210, 173, 1951; Higher transcendental functions, 1, N.Y., 1953, p. 24.

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S/056/61/041/005/025/038
B102/B138

Quantum oscillations of the...

ASSOCIATION: Institut fizicheskikh problem Akademii nauk SSSR (Institute of Physical Problems of the Academy of Sciences USSR)

SUBMITTED: May 31, 1961

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27876

S/020/61/140/001/012/024
B104/B109

24,1200 (1109,1147,1327)

AUTHOR: Gor'kov, L. P.

TITLE: The forces acting on a small particle in an acoustic field in an ideal liquid

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 140, no. 1, 1961, 88-91

TEXT: The author suggests a method for calculating the average forces acting on a particle in any acoustic field in an ideal liquid. The dimensions of the particle are small as compared with the wavelength of the acoustic field. It is shown that it is sufficient to solve the linear scattering problem. As a small particle in the theoretical investigation the authors considered a compressible gas-filled sphere, which could be moved by the forces of the acoustic field. For the velocity potential of a wave scattered by the sphere, the expression

$$\varphi_p = -\frac{R^3}{3\rho r}\dot{\rho}_n f_1 - \frac{R^3}{2} f_2 \, \mathrm{div}\left(\mathbf{v}_n \frac{1}{r}\right), \qquad (7)$$

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The forces acting on a small...

is obtained. R is the radius of the sphere; ρ_0 is the density of the gas of the sphere; ρ is the density of the liquid; ρ_Π is the density of the compressed sphere; $\vec{v}_\Pi$ is the velocity of the incident wave; $f_1 = 1 - c^2\rho/c_0^2\rho_0$; $f_2 = 2(\rho_0 - \rho)/(2\rho_0 + \rho)$. The first term in (7) expresses the "ejection" of mass owing to the compression of the gas in the incident wave. By means of this formula, the following equation is obtained for the potential $U(\vec{r})$ of the forces $\vec{F}$ acting on the sphere:

$$U = 2\pi R^3 \rho \left\{ \frac{\overline{p_\Pi'^2}}{3\rho^2 c^2} f_1 - \frac{\overline{v_\Pi^2}}{2} f_2 \right\} \qquad (12)$$

where c is the velocity of sound, $\overline{p_\Pi'^2}$ and $\overline{v_\Pi^2}$ are averaged values of pressure and velocity at the point where the particle is located. This formula holds for a plane traveling wave. The formula

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$$U(r) = \frac{\overline{Q}R^3}{2c}\left\{\frac{f_1}{3r^3} - \frac{f_2}{2}\left(\frac{1}{r^3} + \frac{1}{k^2r^4}\right)\right\} \quad (15)$$

where $\overline{Q}$ is the intensity of the radiation source, holds for spherical waves. This indicates that e. g. for $f_2 > 0$, $f_1 > 3/2\, f_2$ the particles are attracted by or repulsed from the radiation center, as depending on their distance from the center. $\sqrt{\eta/\varsigma\omega} \ll R$ is the condition for the applicability of the results obtained here. The author thanks Academician L. D. Landau for a discussion and valuable advice. There are 3 references: 1 Soviet and 2 non-Soviet. The reference to English-language publications reads as follows: L. V. King, Proc. Roy. Soc., A147, 212 (1954).

ASSOCIATION: Institut fizicheskikh problem im. S. I. Vavilova Akademii nauk SSSR (Institute of Physical Problems imeni S. I. Vavilov of the Academy of Sciences USSR)

ABRIKOSOV, Aleksey Alekseyevich; GOR'KOV, Lev Petrovich; DZYALOSHINSKIY, Igor' Yekhiyel'yevich; GUROV, K.P., red.; PLAKSHE, L.Yu., tekhn. red.

["Quantum field theory methods in statistical physics] Metody kvantovoi teorii polia v statisticheskoi fizike. Moskva, Fizmatgiz, 1962. 443 p. (MIRA 15:7)

(Quantum field theory)

APPROVED FOR RELEASE: 09/19/2001 CIA-RDP86-00513R000616220006-8"

34653

S/056/62/042/002/043/055
B108/B138

11.3120

AUTHORS: Gor'kov, L. P., Pitayevskiy, L. P.

TITLE: Transition of liquid He^3 into the superfluid state

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 42, no. 2, 1962, 600-605

TEXT: The Cooper effect in He^3, i.e. transition of He^3 to the superfluid state, is investigated. Theoretically, this effect is due to pairing of excitations which attract each other when they are in a state with a sufficiently large orbital angular momentum ($l \gg 1$). The transition temperature is found as

$$T_c^l = (2/\pi)\gamma\tilde{\omega}e^{-1/\varkappa} = (p_0^2/m^*\pi l)\, e^{13/\gamma} e^{-1/\varkappa},$$

$$\varkappa = \frac{3m^* p_0^4 (2l+1) A\Phi}{64}\left[\frac{2l+1}{(l+5/2)(l^2-1/4)(l^2-9/4)}\right] \approx 0{,}99\frac{(l+1/2)^2}{(l+5/2)(l^2-1/4)(l^2-9/4)} \qquad (14)$$

$\Phi = \left\{\left[(2\pi)^2/3\, mm^* c^2\right](3N/8\pi)^{2/3}\right\}^2 = (mc_0^2/m^*c^2)^2$. N - number of atoms per unit volume, m - mass of He^3 atom, m^* - effective mass of excitation,

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c^{-2} - compressibility of liquid He^3, c_0^{-2} - compressibility of ideal Fermi gas with mass m and density N. In fact, pairing of the excitations takes place at not too great l (probably at l = 2), i.e., at temperatures much higher than calculated from the asymptotic formula (14). However, an estimation with the aid of formula (14) (which is applicable only for large values of l), using l = 2, yields $T_c \approx 2\cdot10^{-4}$ °K. On the basis of other estimations it is concluded that T_c probably lies between $8\cdot10^{-3}$ and $2\cdot10^{-4}$°K. E. E. Shnol' and N. D. Vvedenska, collaborators of the Matematicheskiy institut (Institute of Mathematics), are thanked for calculations, S. P. Kapitsa and Academician L. D. Landau for discussions and remarks. Mention is made of N. N. Bogolyubov et al. (Novyy metod v teorii sverkhprovodimosti (A new method in the theory of superconductivity, Izd. AN SSSR, 1958). There are 2 figures and 7 references: 4 Soviet and 3 non-Soviet. The three references to English-language publications read as follows: V. I. Emery, A. M. Sessler. Phys. Rev., 119, 43, 1960; K. A. Bruecner, I. L. Cammel. Phys. Rev., 109, 1040, 1958; A. C. Anderson et al. Phys. Rev. Lett., 6, 331, 1961.

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Transition of liquid He^3 into ... S/056/62/042/002/043/055
B108/B138

ASSOCIATION: Institut fizicheskikh problem Akademii nauk SSSR (Institute of Physical Problems of the Academy of Sciences USSR)

SUBMITTED: September 15, 1961

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APPROVED FOR RELEASE: 09/19/2001 CIA-RDP86-00513R000616220006-8"

24.2140

S/056/62/042/004/027/037
B108/B102

AUTHORS: Abrikosov, A. A., Gor'kov, L. P.

TITLE: Spin-orbit interaction and the Knight shift in superconductors

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 42, no. 4, 1962, 1088 - 1096

TEXT: It is shown that consideration of spin-orbit interaction may provide a quantitative explanation of the frequency shift of nuclear magnetic resonance in superconductors at absolute zero. This Knight shift is proportional to the paramagnetic susceptibility of the conduction electrons. In a polycrystalline small superconductor the electrons undergo scattering from the grain boundaries. Owing to spin-orbit interaction, scattering changes the paramagnetic susceptibility of the superconductor, thereby leading to the Knight shift. Formulas of the type

$$\frac{\chi_s}{\chi_n} = 1 - \Delta^2 \pi T \sum_{-\infty}^{\infty} \frac{1}{(\omega^2 + \Delta^2)\,[\sqrt{\omega^2 + \Delta^2} + 2/3\tau_1]} \quad (18)$$

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S/056/62/042/004/027/037
B108/B102

Spin-orbit interaction ...

are obtained for the paramagnetic susceptibilities. Δ is the energy gap in the spectrum of the pure superconductor at a given temperature. Theory and experimental data are in good agreement. There are 6 figures and 12 references: 3 Soviet and 9 non-Soviet. The four most recent English-language references read as follows: R. A. Ferrell. Phys. Rev. Lett., 3, 262, 1959; P. W. Anderson. Phys. Rev. Lett., 3, 325, 1959; J. Bardeen, J. R. Schrieffer. Progress in Low Temp. Phys., 3, Amsterdam, 1961; G. M. Androes, W. D. Knight. Phys. Rev., 121, 779, 1961.

ASSOCIATION: Institut fizicheskikh problem Akademii nauk SSSR (Institute for Research on Problems of Physics of the Academy of Sciences USSR)

SUBMITTED: November 4, 1961

44240

S/056/62/043/006/045/067
B187/B102

24 7000

AUTHORS: Abrikosov, A. A., Gor'kov, L. P.

TITLE: The nature of impurity ferromagnetism

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 43, no. 6(12), 1962, 2230-2233

TEXT: The ferromagnetism discovered by Matthias et al. (Phys. Rev. 115, 1597, 1959; Phys. Rev. Lett. 1, 44, 92, 1958) in nonmagnetic metals doped with paramagnetic atoms was first explained by the exchange interaction between the impurity atoms and the conduction electrons. This concept was refuted, however, in a paper by Yosida (Phys. Rev. 106, 893, 1957) who argued that such an interaction cannot cause a uniform polarization of the electron spin. The latter is assumed to occur only in the neighborhood of the impurity atoms and to decrease rapidly with the distance from the atom concerned; but this concept is not correct as the decrease does not take place rapidly. The contribution of all impurity atoms to polarization has therefore to be taken into account. The electron density with different spin orientation as a function of the number of randomly distributed

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The nature of impurity... S/056/62/043/006/045/067
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impurity atoms is calculated on the basis of this concept and with the aid of a formula of Yosida. It is shown that spin polarization of the impurity atoms causes uniform electron polarization. Furthermore, the thermodynamic properties of this model are studied. The Curie temperature is determined from the internal and free energies of the system. It is found to be proportional to the impurity concentration. For temperatures above the Curie temperature a formula is given for the paramagnetic susceptibility.

ASSOCIATION: Institut fizicheskikh problem Akademii nauk SSSR (Institute of Physical Problems of the Academy of Sciences USSR)

SUBMITTED: July 3, 1962

Card 2/2

10 1410

S/020/62/144/002/005/028
B104/B102

AUTHORS: Gor'kov, L. P., and Pitayevskiy, L. P.

TITLE: Formation of a shock wave on reflection of a weak discontinuity from sonic line

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 144, no. 2, 1962, 293 - 296

√B

TEXT: The formation of a shock wave was studied under the condition where a weak discontinuity is reflected from a line, along which the flow velocity equals the local velocity of sound (sonic line). Herein it is assumed that the jump of the first derivatives of the velocity of the weak discontinuity on the coordinates is negative. In this case, the discontinuity reflected from the sonic line has the form of a shock wave whose intensity is exponentially small near the point of reflection. If the velocity derivatives are positive, they give rise to weak logarithmic singularities such as have been studied by L. D. Landau et al. (DAN, 96, 725 (1954)). There are 2 figures.

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B104/B102

Formation of a shock....

PRESENTED: December 15, 1961, by L. D. Landau, Academician

SUBMITTED: December 6, 1961

JB

Card 2/2

L 18031-63 EWT(1)/FCC(w)/BDS AFFTC/ASD/IJP(C)

ACCESSION NR: AP3000714 S/0258/63/003/002/0246/0250

57

53

AUTHOR: Gor'kov, L. P. (Moscow)

TITLE: Nonlinear oscillations of gas column

SOURCE: Inzhenernyy zhurnal, v. 3, no. 2, 1963, 246-250

TOPIC TAGS: resonance, shock wave, oscillation, nonlinear effect

ABSTRACT: A simple analysis has been presented to solve the problem of nonlinear oscillation of a gas column in a tube with one end closed by a solid plug and the other by an oscillating piston. The amplitude of the sinusoidially oscillating piston is limited by the assumption $A\omega \ll c$ (A=amplitude, ω=frequency, c=sound speed). The inviscid hydrodynamic equations are integrated using a discontinuous linearized solution neglecting all terms higher than the second approximations. A shock wave appears at resonance frequencies. When the n-th node is excited, n-shocks are present simultaneously. It is shown that for large tubes the effect of viscosity is negligible and energy is dissipated primarily in the shock wave. The expression for the pressure jump across the shock is given by equation

$$\Delta p = 4\rho c_0^2 \sqrt{\frac{A}{2nl}} \sqrt{1 - \frac{\pi^2 l}{8nA} \left(\frac{\Delta\omega}{\omega_n}\right)^2}, \qquad (1)$$

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L 18031-63
ACCESSION NR: AP3000714

4

where p = equilibrium pressure

l = tube length

ω_{01} = fundamental frequency

α = $\frac{1}{2}(\gamma + 1)$

γ = specific heat ratio.

"The author expresses his deep gratitude for the numerous discussions he had with L. D. Landau and P. L. Kapitsa and their influence on this work. The author also thanks A. I. Gulyayev and V. M. Kuznetsov for their help." Orig. art. has: 30 equations and 2 figures.

SUBMITTED: 09Jul62 DATE ACQ: 21Jun63 ENCL: 00

SUB CODE: AI NO REF SOV: 002 OTHER: 004

Card 2/2

GOR'KOV, L.P.

Estimation of the limit critical field strength of rigid superconductors. Zhur. eksp. i teor. fiz. 44 no.2:767-769 F '63. (MIRA 16:7)

1. Institut fizicheskikh problem AN SSSR.

GOR'KOV, L.P.; MELIK-BARKHUDAROV, T.K.

Microscopic derivation of Ginzburg-Landau equations for an anisotropic superconductor. Zhur. eksp. i teor. fiz. 45 no.5:1493-1498 N '63. (MIRA 17:1)

1. Institut fizicheskikh problem AN SSSR.

L 10202-63 EWP(k)/EWT(1)/EWP(q)/EWT(m)/BDS--AFFTC/ASD--Pf-4--
JD
ACCESSION NR: AP3000064 S/0056/63/044/005/1650/1660

AUTHOR: Gor'kov, L. P.; Dzyaloshinskiy, I. Ye.

TITLE: Possibility of zero-sound type of oscillations in metals

SOURCE: Zhurnal eksper. i teoret. fiziki, v. 44, no. 5, 1963, 1650-1660

TOPIC TAGS: Fermi liquids, zero sound, metals

ABSTRACT: Zero-sound electron oscillations in an anisotropic metal are studied on the basis of the theory of the Fermi liquid. Both spin and non-spin oscillations are possible. The latter apparently exist in any type of metal and possess a linear dispersion law throughout the frequency range. Spinless waves can exist if some restrictions are imposed on the magnitude of the Fermi-liquid interaction. For symmetric directions in the crystal, these restrictions can be appreciably relaxed. The non-spin oscillations have two linear regions of the dispersion law, one at radio frequencies and the other in the infrared. The possibility of observing zero sound in metals is discussed. It is pointed out that zero-sound oscillations might manifest themselves also in many other

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L 10202-63
ACCESSION NR: AP3000054

effects, such as line widths in electron diffraction, characteristic losses of charged particles passing through metals placed in magnetic fields, and others. Orig. art. has: 32 formulas.

ASSOCIATION: Institut fizicheskikh problem Akademii nauk SSSR (Institute of Physics Problems, Academy of Sciences SSSR)

SUBMITTED: 20Dec62 DATE ACQ: 12Jun63 ENCL: 00

SUB CODE: PH NR REF SOV: 007 OTHER: 001

bm/

Card 2/2

L 17539-63 EWT(1)/EWP(q)/EWT(m)/BDS AFFTC/ASD/IJP(C) JD
ACCESSION NR: AP3004419 S/0020/63/151/004/0822/0825

AUTHORS: Gor'kov, L. P.; Pitayevskiy, L. P. 55 57

TITLE: Term splitting energy in a hydrogen molecule.

SOURCE: AN SSSR. Doklady*, v. 151, no. 4, 1963, 822-825

TOPIC TAGS: H sub 2 term splitting energy, Heitler-London theory, Schroedinger equation, perturbation theory

ABSTRACT: The energy of the electron terms of a hydrogen molecule are generally computed by the Heitler-London approach in which the initial wave functions are taken as the symmetric and anti-symmetric combinations of wave functions in neutral atoms. Authors attempt to show in this work that this approximation is not valid even for large interatomic distances. Instead, the Schroedinger equation must be solved anew, and the wave functions of electrons within the range of the potential barrier must also be found. Author did this in present study. Results show that the van-der-Waals forces predominate for large interatomic distances, while the exchange forces predominate at small distances. Both forces are of the same order of magnitude at intermediate distances. Orig. art. has: 1 figure and 9 equations.

ASSN: Institute for Physics Problems, Academy of Sciences, SSSR.

Card 1/2

ACCESSION NR: AP4031159 S/0056/64/046/004/1363/1378

AUTHOR: Gor'kov, L. P.; Rusinov, A. I.

TITLE: Ferromagnetism in superconducting alloys.

SOURCE: Zh. eksper. i teor. fiz., v. 46, no. 4, 1964, 1363-1378

TOPIC TAGS: superconductivity, superconducting alloy, ferromagnetism

ABSTRACT: The coexistence of ferromagnetism and superconductivity in alloys containing paramagnetic impurities is demonstrated by the use of a model of impurity ferromagnetism which leads to a linear dependence of the Curie temperature on the impurity concentration in the region of small concentrations. It is assumed that the impurity spins, while being ordered, produce electron-spin density by the exchange interaction with conductivity electrons. The average energy of the impurity-spin interaction with the electron-spin density compensates for the loss in electron kinetic energy. It is shown that, although the addition of impurities depresses the superconducting superconducting transition temperature, it also brings about such a modification of the electron-pair function that the paramagnetic

ACCESSION NR: AP4031159

susceptibility at T = 0 becomes nonzero. This is due to the nonconservation of the electron-pair spin during scattering on the impurity spin. At sufficiently low temperatures, the occurrence of a finite electron susceptibility favors ferromagnetic ordering in the superconducting phase. Orig. art. has 7 figures and 52 formulas.

ASSOCIATION: Institut fizicheskikh problem Akademii nauk SSSR (Institute of Physical Problems, Academy of Sciences, SSSR)

SUBMITTED: 05Oct63 DATE ACQ: 07May64 ENCL: 00

SUB CODE: PH NO REF SOV: 006 OTHER: 005

L 50756-65 EWP(k)/EWP(z)/EWA(c)/EWT(1)/EWT(m)/... [illegible]

AUTHOR: Gor'kov, L. P.; Eliashberg, G. M.

TITLE: ... metallic particles in an electromagnetic ... [illegible]

[illegible]

TOPIC TAGS: many body system, energy level density, [illegible] ...trollable permittivity, metallic particle, metallic particle energy level, metallic particle level denisty, metallic particle polarability, particle specific heat, particle paramagnetic susceptibility

ABSTRACT: A theoretical investigation is made of electron excitations by an altering field in minute metallic particles so small that the excitation spectrum is discrete. The analysis is based on the mean density of levels as determined by the macroscopic characteristics of the metal at very low temperatures. The distribution of levels is described statistically by the method usually applied to highly excited levels of a nucleus. The analysis proceeds from level correlation functions as formulated by Dyson (J. Math. Phys. 3, 140, 157, 166, 1962) and Mehta and Dyson (J. Math. Phys. 4, 713, 1963). It is shown that all three types of level statistics proposed by

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L 50756-65

ACCESSION NR: AP5013900

Dyson are realized in the case under consideration, i.e., in a large aggregate of ... particles of the same size. At low field ... frequencies

... dielectrics with high permitt...

... susceptibility, and ...

... are outlined. Orig. art. has ...

... Institut khimicheskoy fiziki ...

Chemical Physics, Academy of Sciences, SSSR)

SUBMITTED: 02Dec64 ENCL: 00

NO REF SOV: ... OTHER: ...

Card ...

L 1703-66 EWT(1) IJP(c) GG

ACCESSION NR: AP5016571 UR/0056/65/048/006/1772/1775

42
39
B

AUTHOR: Gor'kov, L. P. 44,55

TITLE: Spin-orbit interaction with the lattice and the Knight shift in superconductors 44,55

SOURCE: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 48, no. 6, 1965, 1772-1775

TOPIC TAGS: superconductivity, pair production, spin orbit coupling, crystal lattice, conduction band, conduction electron

ABSTRACT: The effect of the spin-orbit interaction of the lattice electrons on the Knight shift of a superconductor is evaluated. The analysis refers specifically to the interaction with the lattice itself, and not to the spin-orbit interaction of the conduction electrons with external impurities or with the boundary of the sample, so that no dependence on the sample size is involved. The existence of an empty band in addition to the conduction band is assumed. The spin magnetic moment of the conduction electrons in a magnetic field is calculated first in standard fashion and allowance is then made for the superconductivity. The mixing of the functions of the various bands due to the spin-orbit interaction is next accounted for. It is shown that the spin-orbit interaction reduces to a shift of the Fermi

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L 1703-66

ACCESSION NR: AP5016571 3

surface, and cannot be credited with the observed large Knight shift in superconductors. Attention is drawn to the fact that if the shift is indeed independent of the sample size and is equal to 2/3, as in the case of mercury, then this can serve as proof of the fact that Cooper pairing occurs in the triplet state. Orig. art. has: 4 figures and 4 formulas.

ASSOCIATION: Filial instituta khimicheskoy fiziki Akademii nauk SSSR (Branch of the Institute of Chemical Physics, Academy of Sciences SSSR)

SUBMITTED: 19Jan65 ENCL: 00 SUB CODE: NP, SS

NR REF SOV: 002 OTHER: 003

Card 2/2 DP

BYCHKOV, Yu.A.; GOR'KOV, L.P.; DZYALOSHINSKIY, I.Ye.

One-dimensional superconductivity. Pis'. v red. Zhur. eksper. i teoret.fiz. 2 no.3:146-152 Ag '65. (MIRA 18:12)

1. Institut fizicheskikh problem AN SSSR i Institut teoreticheskoy fiziki AN SSSR. Submitted June 15, 1965.

USSR/Diseases of Farm Animals - Diseases Caused by Bacteria and Fungi R

Abs Jour : Ref Zhur Biol., No 5, 1959, 21379

Author : Gor'kov, M.
Inst : -
Title : The Advantages of a Complex Treatment of Cattle Affected with Actinomycosis.

Orig Pub : S. kh. Sibiri, 1958, No 6, 54-56

Abstract : Seventy heads of cattle affected with actinomycosis were divided into 4 groups. The animals of the first group were treated in a complex manner: radical operation, blood transfusion and penicillin. The animals of the second group were given a penicillin injection 24 hours before and after the operation; a blood transfusion was not performed. In the third group penucillin was administered in addition to a blood transfusion without an operative inferference; the animals of the fourth group

Card 1/2

GOR'KOV, M. P. Cand Vet Sci -- (diss) "Blood transfusion in combined treatment of cattle affected with actinomycosis." Omsk, 1959. 17 pp (Omsk State Vet Inst of the Min of Agr RSFSR), 150 copies (KL, 41-59, 105)

GOR'KOV, M.P., dotsent

Tantalum suturing of the parotid duct with an angiorrhaphic apparatus. Veterinariia 41 no.1:80-81 Ja '64.
(MIRA 17:3)

1. Omskiy veterinarnyy institut.

GOR'KOV, M.V., dotsent; PANOV, V.B., student

Radical operations on lungs in calves. Veterinariia 41 no.6:81-82 Je '64. (MIRA 18:6)

1. Omskiy veterinarnyy institut.

GOR'KOV, N.; LYAKHOV, K.

Program of action of the Volga River workers. Rech. transp. 22 no.3:3-4 Mr '63. (MIRA 16:4)

1. Nachal'nik sluzhby ekspluatatsii flota i portov Volzhskogo ob"bedinennogo rachnogo parokhodstva (for Gor'kov). 2. Zamestitel' nachal'nika sluzhby ekspluatatsii flota i portov Volzhskogo ob"yedinennogo rechnogo parokhodstva (for Lyakhov).
(Volga River--Shipping)

[illegible]

[illegible] pomestiar can raise the operational level of the fleet. [illegible] transp. 21 no.8:4-7 Ag '62. (MIRA 15:9)

1. Nachal'nik Sluzhby perevozok i dvizheniya flota Volzhskogo [illegible] rechnogo parokhodstva (for Gor'kov). 2. Nachal'nik [illegible] Inspektsii [illegible] (for [illegible]).

GOR'KOV, P.P.

USSR/Engineering - Mechanics

FD-810

Card 1/1 : Pub. 41 - 2/17

Author : Gor'kov, P. P.

Title : Dynamic action of a fluctuating fluid on a partially-filled tank

Periodical : Izv. AN SSSR, Otd. tekh, nauk 2, 19-24, Feb 1954

Abstract : Presents a solution to the problem of the motion of an ideal incompressible fluid in relation to a cylindrical tank, horizontally placed and moving forward with constant acceleration along a horizontal rectilinear path. Graphs. 5 references.

Institution :

Submitted : By Academician A. I. Nekrasov

GOR'KOV, V. A.

PA - 2576

AUTHOR ELINSON M.I., GOR'KOV V. A., VASIL'YEV G.F.

TITLE Study of the method applied for reduction of autocathode bombardment by the ions of residual gases. (Issledovaniye odnogo sposoba umen' - sheniya bmbardirovki avtoelektronnykh katodov ionami ostatochnykh gazov.-Russian)

PERIODICAL Radiotekhnika i Elektronika 1957, Vol 2, Nr 2, pp 204 - 218 (U.S.S.R.)

Reviewed: 6/1957

Received: 4/1957

ABSTRACT Of the three possibilities of reducing the number of electrons n_i, e.g. by a considerable reduction of the current average value i according to time, by the reduction of N (concentration of residual gas atoms) and of R (under normal conditions R ≈ 1 cm) and of the geometric factor R respectively, the third method is dealt with here. The reduction of R does not mean that the anode has to be in close proximity of the cathode, but a "virtual" anode is produced which is situated as near the emitter as possible and possesses the property that the ions formed between the anode and the cathode get to the point whereas those ions which are formed behind this anode are directed towards the negative electrodes specially intended for this purpose. Several varieties of electrode systems are dealt with which form a "virtual" anode near the point. A four-electron system appears to offer the most ad-

CARD 1/2

PA - 2576

Study of the method applied for reduction of autocathode bombardment by the ions of residual gases.

vantages. The various technological methods worked out by the authors are described. These methods permit all operations to be undertaken with high accuracy and convenience. The process of electrochemically cauterizing the wire point was especially simplified. The various experiments are described, e.g.

1. with active adsorbing films by means of two different methods,
2. experiments of bombarding points of pure tungsten with mercury ions, and
3. tests for the determination of the life of valves and the peculiarities of emission connected herewith.

The system with a strong asymmetric configuration of the electric field is the best means of reducing the detrimental effect of ion bombardment.
(21 illustrations)

ASSOCIATION: not given.
PRESENTED BY: -
SUBMITTED: 30. 7. 1956
AVAILABLE: Library of Congress.

CARD 2/2

GORKOV, V.A. 109-3-1/23

AUTHORS: Yelinson, M.I., Gor'kov, V.A. and Vasil'yev, G.F.

TITLE: Field Emission of Rhenium (Avtoelektronnaya emissiya reniya)

PERIODICAL: Radiotekhnika i Elektronika, 1958, Vol.III, No.3, pp. 307 - 312 (USSR).

ABSTRACT: The field emission of rhenium was investigated by Barnes (Ref.1) but the main shortcoming of his work was the lack of any data on the stability of the emission when the emitter was subjected to ion bombardment. The aim of the present work is to provide the missing data. The investigations reported were carried out on point cathodes made of pure rhenium or of tungsten coated with a layer of rhenium. The rhenium points were prepared by means of an electrolytic etching of thin rhenium bars. A typical rhenium point is shown in Fig. 1. The rheniated tungsten cathodes were prepared by depositing the rhenium electrolytically on to tungsten points. First, the emission patterns of both types of the emitter were photographed (see Figs. 2, 3, 4 and 5) ~~and it was found~~ that in both cases the emitter has the same hexagonal lattice structure. The method of investigation of the emission stability of the point cathodes, when subjected to ion bombardment, was similar to that described by the author

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Field Emission of Rhenium

in an earlier work (Ref.2). The cathodes were subjected to bombardment by mercury ions; the pressure of mercury in the investigated tube could be varied from about 1 to 20 x 10^{-6} mmHg. The experimental curves illustrating the characteristics of rhenium cathodes are shown in Figs. 6 and 7. These are in the form u(t), where u(t) is the voltage across the investigated tube and t is time; the curves are plotted for a constant current; in this way, it is possible to avoid the negative resistance regions and the resulting avalanche-like increase in currents. By comparing the curves of Fig. 7a and b, it is seen that rhenium is about six times more stable than tungsten (the curves of Fig. 7b are for pure tungsten). Some measurements were also made on the field emission of tungsten in the atmosphere of mercury vapours and in the presence of hydrogen. The resulting curves are shown in Fig. 8. The decay of the emission of a pure tungsten cathode and a rheniated tungsten cathode, in the presence of hydrogen, is illustrated in Fig.9 by Curves 1 and 2, respectively. There are 9 figures (including 5 photographs), 1 table and 4 references, 1 of which is Russian, 1 German and 2 English.

SUBMITTED: June 3, 1957

AVAILABLE: Library of Congress

APPROVED FOR RELEASE: 09/19/2001 CIA-RDP86-00513R000616220006-8"

SOV/109-4-6-27/27

AUTHORS: Gor'kov, V.A., Kofanova, T.I.

TITLE: Inter-departmental Seminar on Cathode Electronics (13th Meeting) (Mezhduvedomstvennyy seminar po katodnoy elektronike) (13-e zasedaniye) (New Item)

PERIODICAL: Radiotekhnika i elektronika, 1959, Vol 4, Nr 6, pp 1067 - 1068 (USSR)

ABSTRACT: The meeting of the seminar took place on February 2, 1959, at the Institut radiotekhniki i elektroniki AN SSSR (Institute of Radio-engineering and Electronics of the Ac.Sc., USSR). The following lectures were delivered and discussed:
M.I. Yelinson - "Investigation of the Field Emission of Dielectrics Containing Admixtures";
A.I. Krokhina - "Destruction of the Dielectrics Subjected to Ion Bombardment and Heating";
V.A. Shrednik - "Dependence of the Work Function of the Thin-layer Cathodes on the Coverage Region";
A.P. Rumyantsev - "Influence of the Temperature Processing on the Work Function of the Compounds Having High Melting Points".
The report gives comprehensive summaries of the lectures presented.

26.2312
9.3120 (1003, 1137, 1140)

S/109/60/005/008/018/024
E140/E355

AUTHORS: Yelinson, M.I., Gor'kov, V.A., Yasnopol'skaya, A.A. and Kudintseva, G.A.

TITLE: Pulsed Field Emission at High Current Densities

PERIODICAL: Radiotekhnika i elektronika, 1960, Vol. 5, No. 8, pp. 1318 - 1326 + 1 plate

TEXT: The article concerns the geometry of the widely-used point emitter, as sketched in Fig. 1. The experiments described in the literature have neglected the influence of the cone angle α. Yet this angle has a substantial effect, for the following reasons: it determines the azimuthal field distribution and thus the total emission cone ϑ; more fundamentally, a larger angle improves the heat conduction away from the tip and thus reduces the possibility of a vacuum arc forming; the angle affects the stability of the tip geometry by counteracting surface migration of atoms during heat treatment and by influencing the field distribution close to the emitter it affects the character of ion bombardment of the emitter surface. The present work is concerned primarily

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S/109/60/005/008/018/024
E140/E355

Pulsed Field Emission at High Current Densities

with the geometry of the cone angle α and the pulse field emission of a new class of refractory alloy emitters, using LaB_6 and ZrC points. Tungsten points were also studied as a control. Fig. 2 shows the technique for the successive enlargement of the angle α. Successive etches are made in caustic soda, the tip of the point being masked with globules of acrylic resin. Microphotographs of typical tips, showing a range of angles between 15° and 85° are reproduced in Fig. 3 (note: the scale of c is 10X smaller than the others). It was assumed that Drechsler's approximation (Ref. 4) is valid and therefore only those measurements were employed in the final treatment which fitted this approximation fairly exactly. The volt-ampere characteristics obtained are typified in Fig. 9b, where the rectilinear characteristic at low current densities agrees with the theory of metal field emission. At high current densities there is an appreciable

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S/109/60/005/008/018/024
E140/E355

Pulsed Field Emission at High Current Densities

downwards deviation from rectilinearity. The density at which this deviation occurs is distributed over a wide range - from 3×10^6 to 3.4×10^7 A/cm^2. The working densities of field emission current obtained from the refractory alloys is at least as good as that from tungsten. The deviation of the characteristic from the theoretical is in the opposite direction from the results of Ref. 1, where the deviation is in the direction of higher current densities.
An interesting result of the work is the dependence of pre-arc current density on cone angle α. The relationship is plotted in Fig. 11; the points marked x are the experimental points and the points marked 0 have been corrected for the mean radius of the emitters. The experimental data obtained exceed the theoretical predictions (Ref. 7). Two possible reasons are that the theory neglects thermal radiation and formulates the boundary conditions for large angles α incorrectly. The deviation from rectilinearity at high current densities, noted above, may be due to the influence of space

Card 3/7

S/109/60/005/008/018/024
E140/E355

Pulsed Field Emission at High Current Densities

charge. Another possible reason is that the shape of the potential barrier is not in accordance with the classical image force theory (see the abstract of the previous article - pp. 1315 - 1317). The present authors consider the space charge explanation more likely, and advance a number of reasons. However, the presence of a segment of the characteristic with increased rate of growth of current density requires further consideration. The results indicate that the greater stability and higher working current densities obtained from points with a large cone angle α are advantageous. There are 12 figures and 9 references: 3 Soviet and 6 non-Soviet.

Card 4/4

S/109/60/005/012/034/035
E192/E382

AUTHOR: Gor'kov, V.A.

TITLE: The First Symposium on the Field Emission of Electrons

PERIODICAL: Radiotekhnika i elektronika, 1960, Vol. 5, No. 12, pp. 2069 - 2073

TEXT: The symposium took place in Tashkent during May 10 - 20, 1960.
It was organised by the komissiya po elektronnoy mikroskopii pri Prezidiume AN SSSR (Committee for Electron Microscopy of the Presidium of the AS USSR).
The symposium was attended by representatives of scientific-research establishments, universities and development establishments of Moscow, Leningrad, Tashkent and other towns.
Altogether, 22 papers and short communications were delivered which dealt with field emission of metals and semiconductors, emission of hot electrons and the investigation of physical and chemical processes by means of electron and ion guns.
During the first session, G.N. Shuppe read a review paper on

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S/109/60/005/012/034/035
E192/E382

The First Symposium on the Field Emission of Electrons

"Investigation of the Field Emission of Electrons in the USSR", where he discussed the history of the works dealing with the electron field emission in the Soviet Union. The author attempted also to give a summary of the present state of the investigation of the field emission in the Soviet Union. K.I. Krylov and V.L. Fedorov read a paper on "Field Emission Cathodes Made of a Small-diameter Wire" in which they investigated the field emission cathodes in the form of thin cylindrical rods (diameters of 2-3 μ) made of tungsten. A.P. Komar et al dealt with "Surface Diffusion Coefficients of Beryllium and Tungsten". A.P. Komar et al also considered the problem of "Influence of the Impurity Distribution on the Emission Patterns of Platinum". "The Study of Adsorption, Migration and Evaporation of Cadmium [illegible] Electron Gun" was presented in the [illegible]

Card 2/3

S/109/60/005/012/034/035
E192/E382

First Symposium on the Field Emission of Electrons

Yu.V. Zubenko read a paper entitled "Adsorption, Migration and Evaporation of Barium Deposited on Carburised Tungsten W_2C".

"A Method of Estimating the Influence of a Layer of Adsorbed Atoms on the Work Function of the Electrons of the Base" was described in a paper by V.I. Veksler.

"Investigation of the Form of Monocrystalline Emitters Made of Tungsten Carbide by an Electron Microscope" was described in a paper by Yu.B. Zubenko.

I.L. Sokol'skaya and G.P. Shcherbakov described their work devoted to "Investigation of the High Field Effects in Emitters Made of Monocrystals of Cadmium Sulphide".

K.I. Krylov et al gave a paper on "The Formation of an Electron Beam Produced by a Field-emission Cathode by Means of a Strong Polarised Magnetic Field".

V.A. Shishkin read a paper entitled "Investigation of the Emission Patterns Produced During the Adsorption of Two-atom Molecules and Molecules of Inert Gases".

Card 3/5

S/109/60/005/012/034/035
E192/E382

First Symposium on the Field Emission of Electrons

"Influence of the Temperature of the Point of an Ion Gun on the Surface Ionisation" was discussed in a short paper by N.A. Gorbatyy.
S.Z. Rozhinskiy and V.A. Shishkin described their work on "Investigation of Complex Molecular Patterns of a Number of Anorganic and Organic Compounds".
D.N. Vasil'kovskiy studied "The Problem of Stability of the Edges and the Determination of the Surface Energy in a Crystal".
M.I. Yelinson et al were concerned with "Interpretation of the Shape of Voltage-Current Characteristics of Field Emission in Semiconductors and Metals".
M.I. Yelinson also read a paper by G.F. Vasil'yev dealing with "Influence of the Form of the Surface Potential Barrier and the Field Distribution on the Surface of an Emitter on the Shape of the Voltage-Current Characteristics in the Field Emission".

Card 4/5

S/109/60/005/012/034/035
E192/E382

First Symposium on the Field Emission of Electrons

"The Emission of Electrons from Semiconductors Under the Influence of Strong Electric Fields" was described in a paper by Sh.M. Kogan and V.B. Sandomirskiy.
"The Electron Emission Due to the Influence of a Strong Electric Field From Cylindrical Cathodes Based on SiO_2 + C" was described in a paper by M.I. Yelinson and A.G. Zhdan.
O.D. Protopopov and B.G. Smirnov described the results of their work concerning "The Influence of Silicon and Germanium on Electron Emission From Tungsten Monocrystals".

Card 5/5

20588

S/109/61/006/002/020/023
E140/E435

9.3120 (1003,1137,1140)

AUTHORS: Yelinson, M.I. and Gor'kov, V.A.

TITLE: Certain Features of Field-Emission Cathodes Operating in Microwave Fields

PERIODICAL: Radiotekhnika i elektronika, 1961, Vol.6, No.2, pp.336-339

TEXT: A qualitative analysis is given of the operation of a field-emission cathode in a microwave resonator. Due to the pronounced non-linearity of field emission cathodes the emission in a sinusoidal electrical field occurs in the form of short electron packets. For example, about 42% of the charge emitted during a period can be concentrated in a phase interval of 16°, during which the electric field varies by $\pm$ 0.5%. Experimentally the electron concentration in the packet has been obtained in the range 10^{11} to 10^{14} cm^{-3}. Furthermore, the conditions of ion bombardment for such a field emission cathode are much more favourable than the case of a d.c. device. There are 5 figures and 3 references: 2 Soviet and 1 non-Soviet.

SUBMITTED: October 19, 1960

Card 1/1

S/109/61/006/006/016/016
D204/D303

AUTHORS: Vikhlayeva, R.P., Gor'kov, V.A., and Zhdan, A.G.

TITLE: Inter-departmental seminar on cathode electronics (18th Meeting)

PERIODICAL: Radiotekhnika i elektronika, v. 6, no. 6, 1961, 1031 - 1032

TEXT: This is a report on the 18th meeting of the mezhduvedomstvennyy Seminar po Katodnoy elektronike (Inter-departmental Seminar on Cathode Electronics) held February 6, 1961 at the Institut radiotekhniki i elektroniki (Institute of Radio Engineering and Electronics) AS USSR. 10 papers were read. V.A.Grodko, B.N. Markar'yan, V.S. Zolatarevskiy and I.M. Rubanovich, in their paper "The Conditions of Applicability of the Richardson - Dushman Equation in Analyzing Characteristics of a Thermo-Electric Converter", analyzed the characteristics of a thermo-electric diode converter and showed that the emission coefficients $A = A_0(1 - \bar{R})$, where A_0 =

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120.4 amp/cm^{-2} (^{o}C)$^{-2}$, $\bar{R}$ - the reflections determined by basic laws of thermodynamics. A method of determining the characteristics of such converter was suggested, based on the application of existing experimental data on thermionic emission of materials which answer the requirements of the laws of thermodynamics. L.N. Dobretsov and I.A. Rezgol, who participated in the discussion, pointed out several inaccuracies resulting mainly from the interpretation by the authors of quantity A. G.V. Stepanov, V.I. Pokalyakin and M.I. Elinson presented the paper "Peculiarities of the Emission of Hot Electrons from Spontaneous p - n Junctions in SiC Crystals". The authors have been observing the high current density emissions from small size luminescent points, at various temperatures and various values of back bias applied to the junction. A sharp increase of emission current and tendency of saturation were observed up to the moment of the carrier avalanche effect. A sprayed coating of BaO at the junction surface produces a large increase of the emission current. I.M. Bronshteyn and B.S. Frayman read two papers: "The Inelastic Scattering of Electrons and Secondary Electron Emis-

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sion from Thin Layers of Certain Metals and Semi-Conductors" and "The Influence of Work Function on the Secondary Emission". In the first work, the authors experimentally established all possible presentations of the $\delta - \eta$ diagrams (where δ and η - the slow and fast components respectively of the secondary emission) when depositing one material on to a base made from a different one. The diagrams $\delta - \eta$ permit evaluation of the effectiveness δ_0 of primary electrons penetrating in depth and of inelastically reflected electrons S and also of the trajectories of slow truly secondary electrons. The results were given for sprayed coating of Pb on Si and Al; of Ti on Ag, Be and Al; of Al on Pb and Ti, of Si on Pb. In their second work with the help of $\delta - \eta$ diagrams it was shown that with the change of the work function of the emitter and as a result of absorption at its surface of foreign matter (Ca on Be and Ag; Ba on Be and Ti; Be, Ti, Ag on Ba; Be on Ca), the observed change in the coefficient of secondary emission depends basically on the change in δ. The values of δ_1, δ_0, and S were obtained for

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Ba and Ca and the role of the "reflected" stream, in the generation of truly secondary emission electrons, is now established. Yu. G. Anikeyev and B.N. Popov read the paper "Secondary Emission of Barium Oxide"; they measured the secondary emission of BaO under pulse voltages and with cathodes having a wide range of their parameters variation, such as the pressure of CO_2 (from 10^{-8} to 10^{-5} mm Hg) and excess of barium in the cathode. The obtained absolute value of the coefficient of secondary emission was in good agreement with values obtained by other authors. At temperatures below 550°C this coefficient is independent of T for all states of activity of the cathode. At high temperatures the coefficient is independent of T if the cathodes have low activation, rises exponentially for medium activated cathodes and falls slightly if cathodes are highly activated. S.V. Izmaylov presented a paper on "The Theory of Secondary Electron Emission". He analyzed the influence of primary electrons, being reflected in the layer of the material on the emission of secondary electrons. Developing the assumptions of D. Youker, the author succeeded in obtaining a more accurate

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analytical expression for the current of secondary emission electrons. E.S. Parilis and P.M. Kishinevskiy read two papers, "Energy Spectrum of Ion-Electron Emission" and "The Mechanism of Ion-Electron Emission and its Dependence on the Ion Velocity". In the first a mechanism of emission of excited electrons from the metal was suggested which could explain theoretically the form of the energy spectrum and evaluate the position of the maximum, its half-width and the maximum energy of electrons. The emission of electrons in vacuum is considered as a result of Auger recombination of the conduction electron with a hole in the filled zone, formed by collisions of ions with the atoms of metal, the probability of Auger recombination being evaluated using the wave functions of Bloch. The authors gave a comparison of theoretical curves with experimentally obtained data. The second paper is a further development of the mechanism of the kinetic ion-electron emission suggested earlier by the authors, based on a statistical analysis of an inelastic collision of the ion with the metal atoms, accompanied by a hole formation in the filled band with a consequent Auger re-

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combination with conduction electron, which reduces to the emission of electron into the vacuum. The movement of the electron is analyzed using the classical method of the Thomas-Fermi model. A formula for the coefficient γ of ion-electron emission was obtained, which determines the dependence of γ on the velocity (u) of the ion; the authors also compared the theoretical curves $\gamma = f(u)$ with the experimental data for different ions in W and Mo, which proved to be in good agreement. The paper on "Mobility of Anti-Emitting Properties of Metals under the Influence of Carbon Dioxide" was presented by B.Ch. Dyubua and B.N. Popov. The authors determined the heat absorption of Ba at the surface of various metals. According to the decrease of absorption the metals can be put in the following sequence: Rh, Sr, Pt, Re, Mo W, Ti, Hf, Zr. Experimental data have been produced which confirm the theory. It has been established that Zr has the best anti-emission properties. It was shown that both pure and coated Ba, Ti, Zr and Hf possess increased emission stability under the action of O_2 as compared with W. The composition of gases in the experiments was controlled by means of a

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simple omegatron. In their paper Ye.S. Zhmud', Ye.P. Ostapchenko, A.I. Figner and I.V. Yudniskiy, "Certain Physical Properties of Complex Compounds, Based on Barium and Maximum Oxides" presented the results of investigations into the physico-chemical and thermo-electric properties of systems based on oxides of barium and of hafnium taken in various molar proportions. The systems were prepared by sintering together the mixtures of powdered raw materials. The phase composition of samples having different molar ratios of constituents was determined using x-ray analysis. As the result of their study the authors discussed the presence of a chemical compound of $BaHfO_3$.

CHAYNOVET, A. [Chynoweth, A.G.]; GOR'KOV, V.A. [translator]; ZHDAN, A.G. [translator]

Internal field emission. Usp. fiz. nauk 75 no.1:169-196 S '61. (MIRA 14:9)

(Semiconductors) (Field emission)

BALASHOVA, A.P.; GOR'KOV, V.A.; ZHDAN, A.G.; KUL'VARSKAYA, B.S.; PARILIS, E.S.; POLYAKOVA, M.A.; YURASOVA, V.Ye.; YASNOPOL'SKIY, N.L.

Tenth Congress on Cathode Electronics. Radiotekh. i elektron 7 no.7:1258-1272 '62. (MIRA 15:6)

(Electronics—Congresses)

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S/109/62/007/009/004/018
D409/D301

AUTHORS: Gor'kov, V.A., Yelinson, M.I., and Sandomirskiy, V.B.

TITLE: On the role of the space charge in drawing field-emission currents of high density

PERIODICAL: Radiotekhnika i elektronika, v. 7, no. 9, 1962, 1495 - 1500

TEXT: The possible causes are considered of the observed deviation of the current-voltage characteristics of field-emission of metals at high current densities. In this connection the authors analyze the role of the space charge and of the shape of the potential barrier at the boundary emitter-vacuum. It is shown that if a sufficiently strong positive space-charge is formed in the emitter-anode space (e.g. by ionized residual-gas molecules), this leads to a certain type of deviation of the current-voltage characteristics. First, the space charge is calculated by an approximate method. The calculations are checked by experiment. The pressure in the experimental diode varied between 10-8 and 10-4 mm Hg. The preparation of the tungsten emitters, as well as the experimental procedu-

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re were described in the references. It is concluded that the initial region of deviation of the current-voltage characteristics is mainly due to the influence of the space charge. The barrier effects are apparently weak and appear in the region of higher electric field strength. The experimentally observed shift of the entire current-voltage characteristic towards larger values of the field, is apparently due to the polarization of residual-gas molecules. There are 3 figures. The most important English-language reference reads as follows: N.C. Barford, J. Electronics and Control, 1957, 3, 11, 163.

SUBMITTED: January 30, 1962

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YELINSON, M.I.; SANDOMIRSKIY, V.B.; GOR'KOV, V.A.; ZHDAN, A.G.

Reply to G.N. Shuppe's and A.S. Kompaneits letter to the editor concerning V.A. Gorkov's article "The first symposium on field emission." Radiotekh. i elektron. 7 no.9:1686-1688 S '62.

(MIRA 15:9)

(Field emission) (Shuppe, G.N.) (Kompaneits, A.S.) (Gor'kov, V.A.)